General Biology

ADAPTATION AND EFFICIENCY IN THE BLOWFLY PHOTORECEPTOR

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Every brain paints a different picture of the world. Different organisms paint a different piece as information capacity is a fundamental and quantitative bound on the ability of a physical system to communicate information. In other words, organisms receive behaviourally relevant information that they need in order to survive. Biological systems operate at performance levels set by fundamental physical limits, under severe constraints of size, weight, structural composition, and energy resources.

This study looks at the Blowfly photoreceptor as a Biological Information and Communication System operating under certain physical and biophysical constraints. Information capacity and metabolic costs are two such major constraints on neural processing. A simple theoretical model of the Blowfly photoreceptor was developed using Mathcad. The model predicts how the photoreceptor adapts to its wide input range by reducing the gain of the biochemical cascade with increasing light levels, which is one of the various mechanisms it uses to light adapt.

Noise is fundamental to any information system. Intrinsic noise puts a fundamental limit to the information capacity of the system. The information rates would continue to increase indefinitely with zero intrinsic noise. The model predicts that on reducing gain with increasing light levels the photoreceptor tends to maximise its information capacity and minimise its metabolic costs. The cost per bit operates at lower gains as compared to the information capacity at a particular light intensity.